Commercial Space Transportation

QUARTERLY LAUNCH REPORT

Featuring the launch results from the 1st quarter 2003 and forecasts for the 2nd quarter 2003 and 3rd quarter 2003

Quarterly Report Topic:

Launch Delays and Scrubs: The Eastern Range As a Case Study

2nd Quarter 2003

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Associate Administrator for Commercial Space Transportation
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Introduction

The Second Quarter 2003 Quarterly Launch Report *features launch results from the first quarter of 2003 (January-March 2003) and launch forecasts for the second quarter of 2003 (April-June 2003) and third quarter of 2003 (July-September 2003). This report contains information on worldwide commercial, civil, and military orbital space launch events. Projected launches have been identified from open sources, including industry references, company manifests, periodicals, and government sources. Projected launches are subject to change.*

This report highlights commercial launch activities, classifying commercial launches as one or both of the following:

- *Internationally-competed launch events (i.e., launch opportunities considered available in principle to competitors in the international launch services market)*
- *Any launches licensed by the Associate Administrator for Commercial Space Transportation of the Federal Aviation Administration under 49 United States Code Subtitle IX, Chapter 701 (formerly the* Commercial Space Launch Act)

Contents

Cover: An Atlas 3B provided by International Launch Services (ILS) successfully launched AsiaSat 4 to geosynchronous orbit (GEO) from Cape Canaveral Air Force Station on April 11, 2003.

First Quarter 2003 Highlights

The last of the Ariane 4 series was launched successfully from Kourou on February 15. The Ariane 44L placed Intelsat 907, built by Space Systems/Loral, into geosynchronous orbit (GEO).

An inquiry board appointed to investigate the failure of Ariane 5 Flight 157 on December 11, 2002 submitted its report to Arianespace on January 6, 2003. The board concluded that the most probable cause of the failure was the simultaneous occurrence of two factors: the degraded thermal condition of the nozzle due to fissures in the cooling tubes, and the non-exhaustive definition of the loads to which the Vulcain 2 engine is subjected during flight.

Also in January, a failure review board convened by International Launch Services (ILS) completed its investigation into the failed Proton launch carrying Astra 1K on November 26, 2002. The failure left the satellite in a lower-than-planned orbit. The failure was attributed to contamination in engine components of the Block DM upper stage. The propellant used was not cited as a potential root cause, however.

Four new teams entered the X-PRIZE competition during the first quarter of 2003. These are American Astronautics Corporation, Interorbital Systems (IOS), IL Aerospace Technologies (ILAT), and Micro-Space, Inc. There are now 24 X-PRIZE competitors from seven countries: Argentina, Canada, Israel, Romania, Russia, the United Kingdom, and the United States.

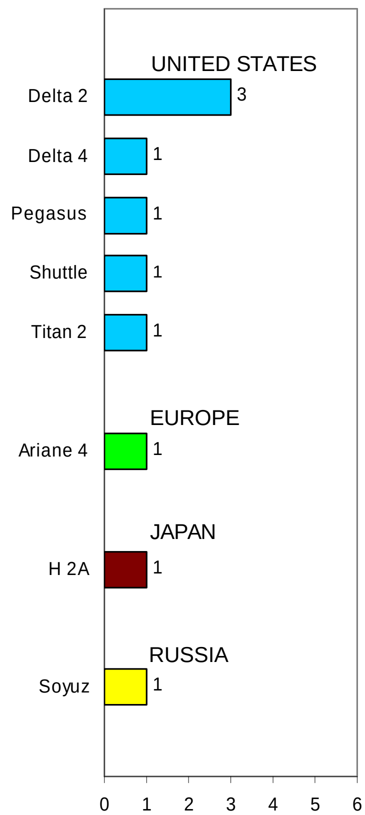
The U.S. Department of Defense is willing to provide financial support to both Evolved Expendable Launch Vehicle (EELV) manufacturers, Boeing and Lockheed Martin, but at lower levels than previously discussed. The U.S. Air Force plans to give a combined $538 million to support Boeing’s Delta 4 and Lockheed Martin’s Atlas 5 over the next several years. The Air Force also plans to award future EELV launch contracts during 2003. Under review is a proposal stating that neither company would be allowed to win more than 60 percent of the contracts.

The Defense Advanced Research Projects Agency (DARPA) selected Space Launch Corporation in March as the sole winner of Phase 2 of a program to develop a low-cost small launcher. Space Launch Corporation was one of the six companies selected in April 2002 as Phase 1 winners of the Responsive Access Small Cargo Affordable Launch (RASCAL) program to develop a partially reusable two-stage vehicle. DARPA had planned to select two Phase 2 contract winners and later down-select to a single company that would build the RASCAL vehicle, but decided to select only one company to save money. DARPA will decide at the end of Phase 2 whether or not to proceed with construction of the vehicle, which is scheduled to be ready for flight in fiscal year 2006. The value of the contract was not disclosed.

Space Exploration Technologies Corporation (SpaceX), the third company founded by Internet entrepreneur Elon Musk, successfully test fired the company's Falcon rocket main engine in March 2003. Musk founded SpaceX in June 2002 with the goal of developing small launch vehicles that provide highly reliable low-cost access to space. The first launch of the Falcon launch vehicle could occur as early as late 2003.

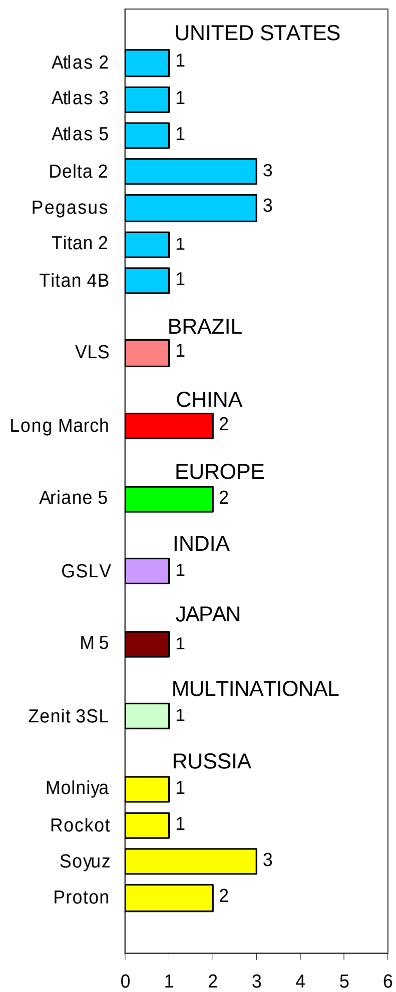
Vehicle Use
(January – September 2003)

Figure 1: First Quarter 2003 Total Launch Vehicle Use



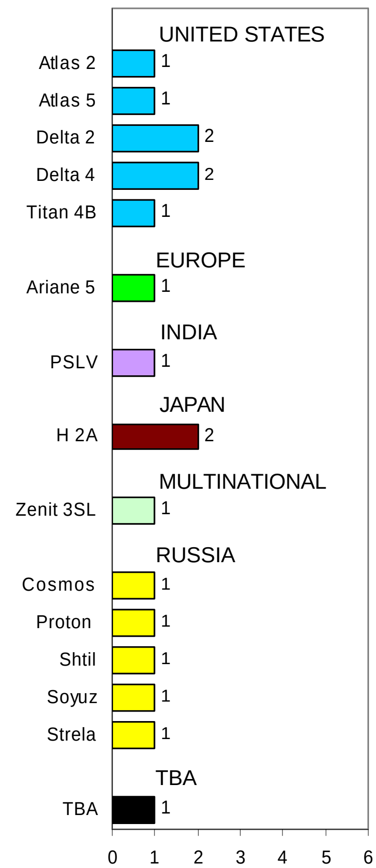
Total = 10

Figure 2: Second Quarter 2003 Total Projected Launch Vehicle Use



Total = 26

Figure 3: Third Quarter 2003 Total Projected Launch Vehicle Use



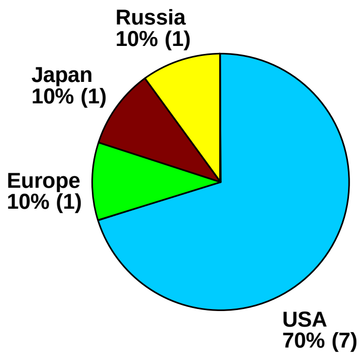
Total = 18

Figures 1-3 show the total number of orbital launches (commercial and government) of each launch vehicle that occurred in the first quarter of 2003 and those that are projected for the second and third quarters of 2003. These launches are grouped by the country in which the primary vehicle manufacturer is based. Exceptions to this grouping are launches performed by Sea Launch, which are designated as multinational.

Total Launch Events by Country

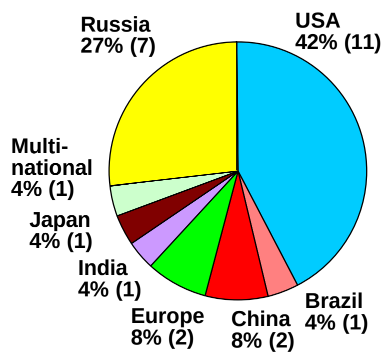
(January – September 2003)

Figure 4: First Quarter 2003 Total Launch Events by Country



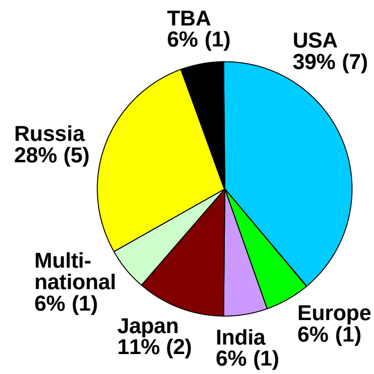
Total = 10

Figure 5: Second Quarter 2003 Total Projected Launch Events by Country



Total = 26

Figure 6: Third Quarter 2003 Total Projected Launch Events by Country



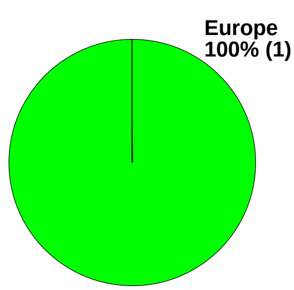
Total = 18

Figures 4-6 show all orbital launch events (commercial and government) that occurred in the first quarter of 2003 and those that are projected for the second and third quarters of 2003.

Commercial Launch Events by Country

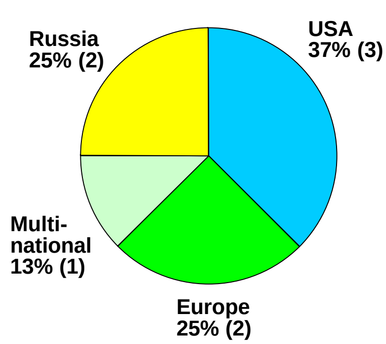
(January – September 2003)

Figure 7: First Quarter 2003 Commercial Launch Events by Country



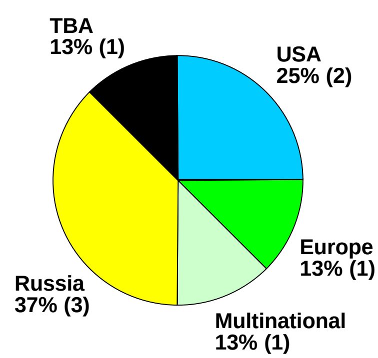
Total = 1

Figure 8: Second Quarter 2003 Projected Commercial Launch Events by Country



Total = 8

Figure 9: Third Quarter 2003 Projected Commercial Launch Events by Country



Total = 8

Figures 7-9 show all *commercial* orbital launch events that occurred in the first quarter of 2003 and those that are projected for the second and third quarters of 2003.

Commercial vs. Non-commercial Launch Events

(January – September 2003)

Figure 10: First Quarter 2003 Commercial vs. Non-commercial Launch Events

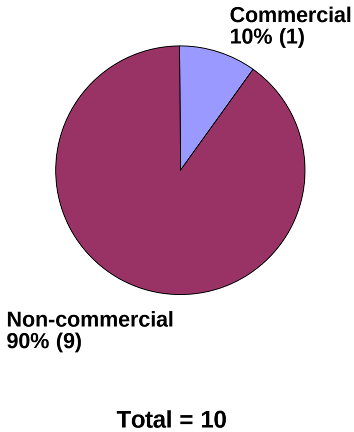


Figure 11: Second Quarter 2003 Projected Commercial vs. Non-commercial Launch Events

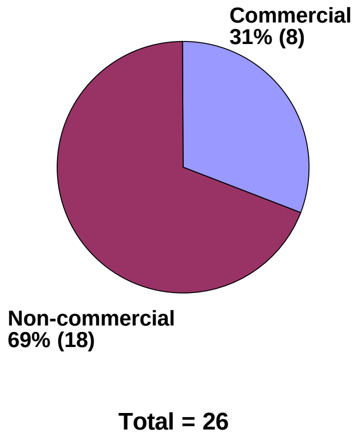
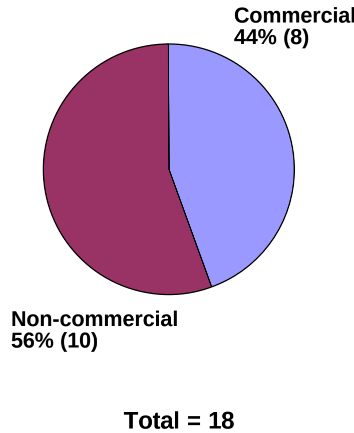


Figure 12: Third Quarter 2003 Projected Commercial vs. Non-commercial Launch Events



Figures 10-12 show commercial versus non-commercial orbital launch events that occurred in the first quarter of 2003 and those that are projected for the second and third quarters of 2003.

First Quarter 2003 Launch Successes vs. Failures

(January – March 2003)

Figure 13: Total Launch Successes vs. Failures

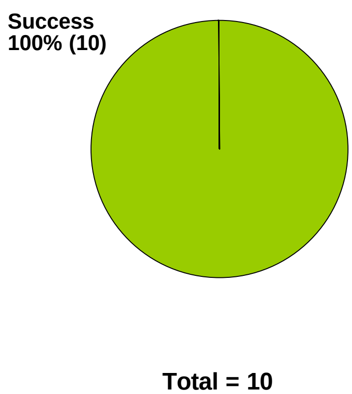
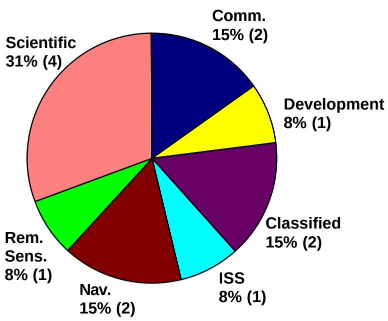


Figure 13 shows successful versus failed orbital launch events that occurred in the first quarter of 2003.

Payload Use

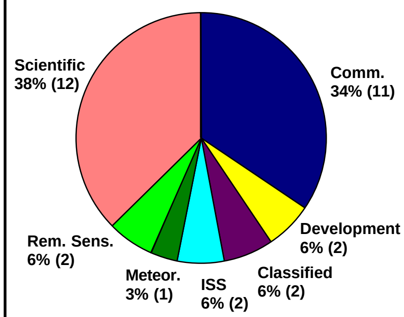
(January – September 2003)

Figure 14: First Quarter 2003 Payload Use



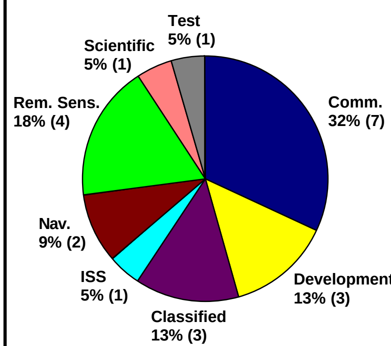
Total = 13

Figure 15: Second Quarter 2003 Projected Payload Use



Total = 32

Figure 16: Third Quarter 2003 Projected Payload Use



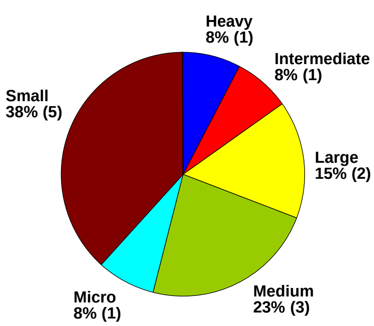
Total = 22

Figures 14-16 show total payload use (commercial and government): actual for the first quarter of 2003 and projected for the second and third quarters of 2003. The total number of payloads launched may not equal the total number of launches due to multi-manifesting (i.e., the launching of more than one payload by a single launch vehicle).

Payload Mass Class

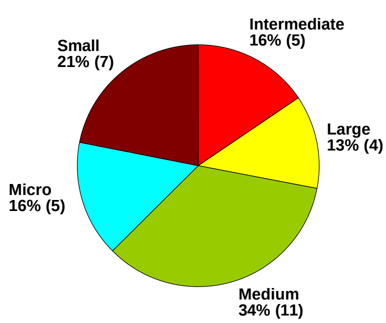
(January – September 2003)

Figure 17: First Quarter 2003 Payload Mass Class



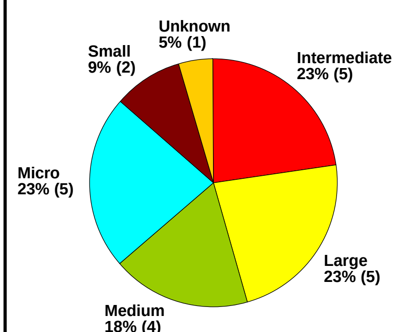
Total = 13

Figure 18: Second Quarter 2003 Projected Payload Mass Class



Total = 32

Figure 19: Third Quarter 2003 Projected Payload Mass Class



Total = 22

Figures 17-19 show total payloads by mass class (commercial and government): actual for the first quarter of 2003 and projected for the second and third quarters of 2003. The total number of payloads launched may not equal the total number of launches due to multi-manifesting (i.e., the launching of more than one payload by a single launch vehicle). Payload mass classes are defined as Micro: 0 to 91 kilograms (0 to 200 lbs.); Small: 92 to 907 kilograms (201 to 2,000 lbs.); Medium: 908 to 2,268 kilograms (2,001 to 5,000 lbs.); Intermediate: 2,269 to 4,536 kilograms (5,001 to 10,000 lbs.); Large: 4,537 to 9,072 kilograms (10,001 to 20,000 lbs.); and Heavy: over 9,072 kilograms (20,000 lbs.).

Commercial Launch Trends

(April 2002 – March 2003)

Figure 20: Commercial Launch Events, Last 12 Months

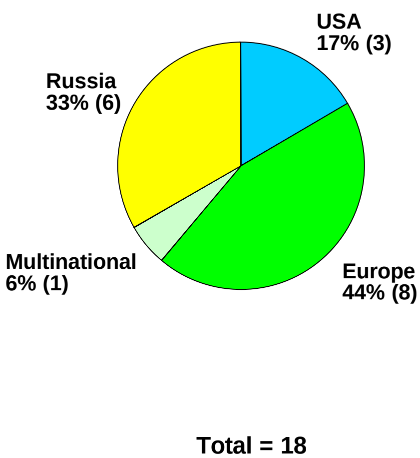


Figure 21: Commercial Launch Revenue, Last 12 Months

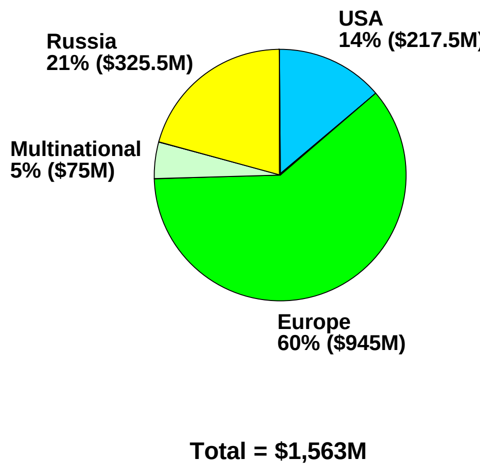


Figure 20 shows commercial launch events for the period April 2002 to March 2003 by country.

Figure 21 shows commercial launch revenue for the period April 2002 to March 2003 by country.

Figure 22: Commercial Launch Events by Country, Last Five Years

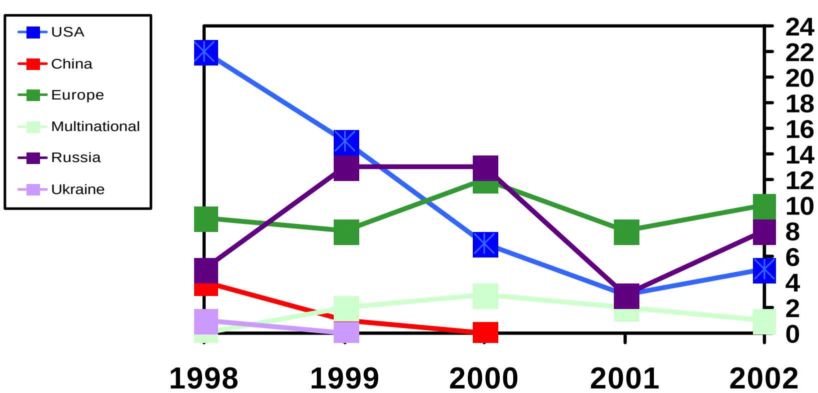


Figure 22 shows commercial launch events by country for the last five full years.

Figure 23: Commercial Launch Revenue (in $ million) by Country, Last Five Years

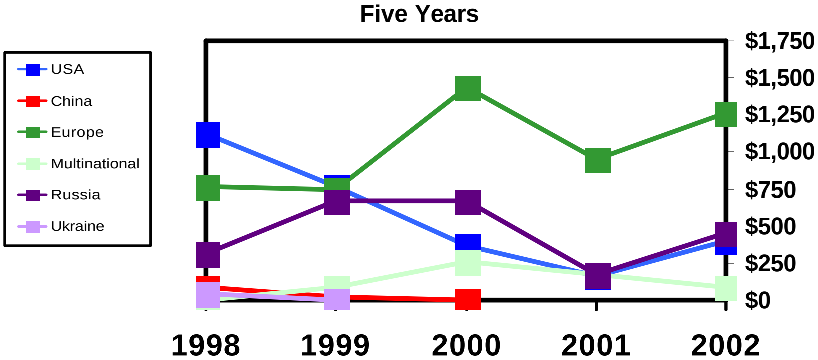


Figure 23 shows commercial launch revenue by country for the last five full years.

Launch Delays and Scrubs: The Eastern Range As a Case Study

INTRODUCTION

Launch campaigns are complex endeavors that often fail to occur on schedule. Some of these schedule slips are related to the technologies involved; others are caused by human error or environment factors. The purpose of this report is:

- To briefly describe the main causes of launch schedule slippage;
- To provide statistics showing how often each type of slippage occurs; and
- To determine which type of slippage is the most common during a typical launch campaign.

Definitions

A launch campaign is defined as beginning with the delivery of the payload to the launch site and concluding at the end of the recovery phase. The launch window is the period of time optimal (in terms of fuel, collision avoidance, and time) for accessing an orbit according to mission parameters.

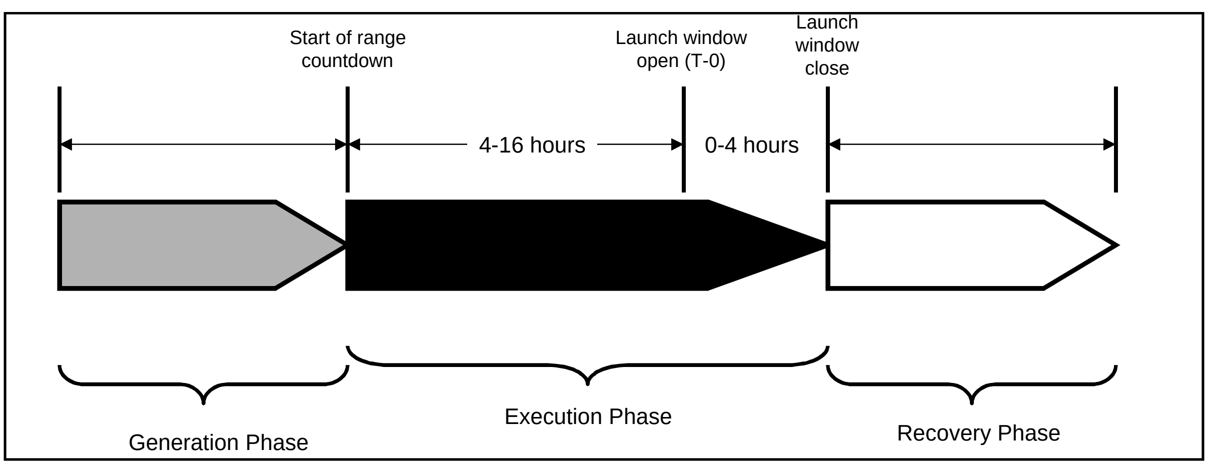
A launch delay is a schedule slippage due to unplanned circumstances, but the vehicle still launches within the launch window. A launch scrub terminates the countdown and the launch is rescheduled if a problem (either customer-, range-, or weather-related) occurs that the launch team believes cannot be resolved prior to the end of the launch window.

Since detailed data could only be obtained from the Eastern Range, the focus of this report will be placed on commercial and non-commercial launch campaigns that have taken place from Kennedy Space Center (KSC), and the Cape Canaveral Air Force Station (CCAFS). Collectively, KSC and CCAFS are known as the Cape Canaveral Spaceport (CCS). The Eastern Range also includes tracking and telemetry assets located at Antigua in the West Indies, Ascension in the South Atlantic, Argentia in Newfoundland, Jonathan Dickinson Missile Annex in Florida, and numerous other sites in Florida.

TYPICAL LAUNCH CAMPAIGN

A typical launch campaign is divided into three phases: the generation phase, the execution phase, and the recovery phase (see Figure 1). Delays can occur during both the generation and execution phases, but scrubs are called only during the execution phase. An on-time launch is one that takes place at the opening of the launch window.[1]

Figure 1. Phases of a Typical Launch Campaign



A launch delay is an unplanned hold during either the generation or execution phases that will cause a scheduled launch to occur beyond the planned T-0 count, or the moment when a launch window opens. The delay can be caused by many factors grouped into three general categories: customer-related, weather-related, and range-related. For instance, a delay in delivery of a payload during the generation phase may cause a delay in the scheduled launch. If the delay is significant in terms of duration, or if several delays take place during the execution phase pushing the planned event beyond the launch window, the launch is scrubbed. The cost of a launch scrub varies from $150,000 to over $1,000,000, depending upon the launch vehicle.[2]

Rescheduling a launch is not normally a major problem for customers with payloads destined for Earth orbit, since launch windows recur frequently. However, for those customers with payloads heading to points beyond the Earth-Moon system, the next available launch window may be several years away. In addition, rescheduling a launch may require rescheduling other launches using the same range in the immediate future, a condition described as "ripple effect."

DELAYS DURING THE LAUNCH GENERATION PHASE

For this report, statistics were only available for delays and scrubs during the launch execution phase, which begins when the countdown clock is initialized. As a result, only a qualitative discussion for delays which occur during the generation phase of a launch campaign follows.

Customer Factors

Customer factors may involve the payload, the launch vehicle, ground support equipment (GSE), or a combination of these.

During development and construction, the launch of a payload is only tentatively scheduled within a quarter or month. As the payload nears completion, a more precise launch date can be selected, a process that is also determined by launch windows and range availability. During the generation phase, a payload may experience unforeseen manufacturing hurdles or encounter design problems, making the planned launch date even more uncertain. Design and construction schedules often account for manufacturing delays, but these delays can sometimes extend beyond even these schedule reserves. The reasons for such extended delays are rarely published due to the sensitive nature of such manufacturing and schedule issues.

While satellite manufacturing delays do play a part in delaying launches at CCS, the Sea Launch Corporation has also experienced a significant number of delays, preventing the launch service provider from realizing its goal of six launches per year. All launches scheduled for this year (six were anticipated in January) have been delayed due to delayed delivery of satellites from manufacturers.

Related to satellite manufacturing, but more specifically having to do with design, a particular satellite may experience a malfunction while on orbit. Sometimes, these problems can be mitigated using software patches or other remote methods. In other cases, the malfunction sheds light on a critical design flaw than can at best reduce the satellite's service life and at worst terminate the satellite's effectiveness altogether. When the design flaw is traced to a specific bus or component that is planned for use by other operators, manufacturing of affected future satellites is stopped while an investigation takes place to isolate the cause and determine a corrective action. Delays in satellite delivery because of this kind of technical issue are highly variable, but can be quite lengthy. In-orbit anomalies have intensified quality control efforts in recent years, lengthening schedules well beyond the expected date of a satellite's completion.[3]

Export controls also play a significant role in the delay of a satellite's delivery to the launch site. Indeed, while relatively low in frequency, delays related to export control paperwork can effectively ground a satellite for years at a time, imposing significant costs on the operator for both storing the satellite and in lost revenue.

Once a payload is delivered to the launch site it must be checked out at a payload processing facility, then integrated with the launch vehicle. Payload and launch vehicle integration also present opportunities for the delay of a launch, though this appears to be less of a factor than one might assume. Instances have occurred when a satellite or launch vehicle has been damaged during the integration process, potentially delaying the launch for months at a time. Sometimes problems are revealed during the integration process, such as dust on solar panels. Usually, these kinds of problems are corrected quickly and the integration process can continue.

The development and manufacture of the launch vehicle itself may be a source for launch delays. Manufacturing problems may arise during the construction of a particular vehicle, or a previous failure of a vehicle may ground the vehicle type during the accident investigation until a root cause for the failure is addressed. It should be noted that the failure of a particular launch vehicle may be the result of a malfunctioning component or system of components common to other vehicle types, grounding them as well.

Only when the payload and vehicle are fully integrated, and the combination is installed and declared ready on the launch pad, can the launch execution phase begin. For most missions, the beginning of the launch execution phase marks the start of the countdown clock.

Weather Factors

Certain weather conditions can pose a delay risk during the launch generation phase. This risk is assessed well in advance during the launch vehicle design process. The weather parameters within which a vehicle can operate are very specific to each vehicle and mission. The range also has its set of weather safety guidelines that must be taken under consideration in conjunction with vehicle operating constraints.

During the generation phase, weather determined to be substantial enough to affect operations during the execution phase, which typically covers a period lasting between 4 to 20 hours, will be critically assessed. When evaluating weather conditions, hurricanes and other large storm systems are obvious examples of weather events that will not only delay a launch, but scrub it altogether until the system passes. Examples of other weather elements that may extend into the launch execution phase include temperature extremes (particularly low temperatures), surface winds, winds aloft, low cloud ceilings, poor visibility, precipitation, and thunderstorm activity. The precise nature of these transient conditions is very difficult to forecast through the generation phase into the execution phase.

Range Factors

The Eastern Range consists of operations control centers, radar systems, optical trackers, telemetry receivers and processors, command transmitters, weather instruments, communications assets, and various surveillance systems. Despite this seemingly complex infrastructure, the range is not a major contributor of launch delays, particularly during the generation phase of a launch campaign. However, the Eastern Range was unavailable to support operations for almost 60 days in 1998 due to scheduled modernization activities.[4] While not technically a delay factor during the generation phase of a launch campaign because its planned execution was known well in advance, it is an example of a factor that does have an impact upon launch service providers and payload operators alike due to lack of range availability.

DELAYS AND SCRUBS DURING THE LAUNCH EXECUTION PHASE

Because detailed launch delay and scrub information for the execution phase of launch campaigns is available from the Eastern Range, a quantitative description and analysis of the data for CCS can be conducted. Note that only the first cause for a launch delay or scrub is counted in this report. Less detailed information gleaned from mainstream media sources is also used when appropriate to describe similar issues at other launch sites. At the Eastern Range, 555 countdowns were conducted during fiscal years 1988 through 2002. Of those, 370 (67 percent) were launched within the scheduled launch window, while 185 (33 percent) were scrubbed (see Figure 2). On time launches accounted for 203 of the launches (37 percent of 555 total launch campaigns, or 55 percent of the 370 launched within the launch window). Launch delays occurred during 167 launch campaigns (30 percent of 555 total launch campaigns, or 45 percent of those launched within the launch window).

Figure 2. On Time Launches, Delayed Launches, and Scrubbed Launches (FY1988 - FY2002)

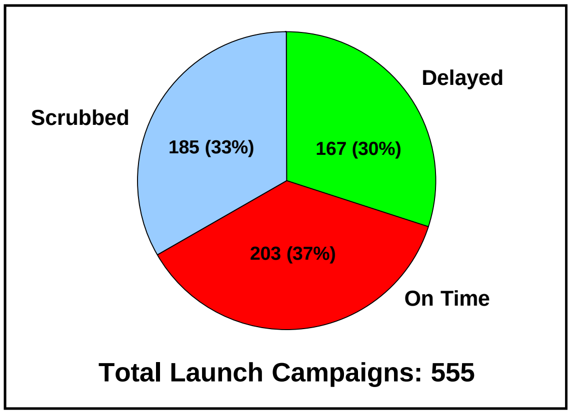


Figure 3 shows that of the 167 launch campaigns that experienced delays, 72 were delayed due to customer factors (13 percent of 555 total launch campaigns), 52 were delayed for weather factors (9 percent of total), and 43 were delayed for range issues (eight percent).

Figure 3. Delayed Launches by Cause Factor (FY1998 - FY2002)

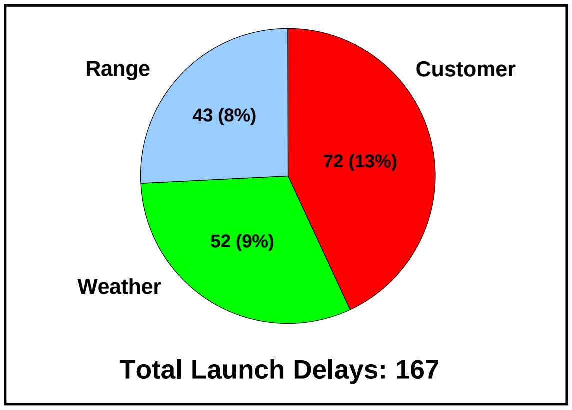
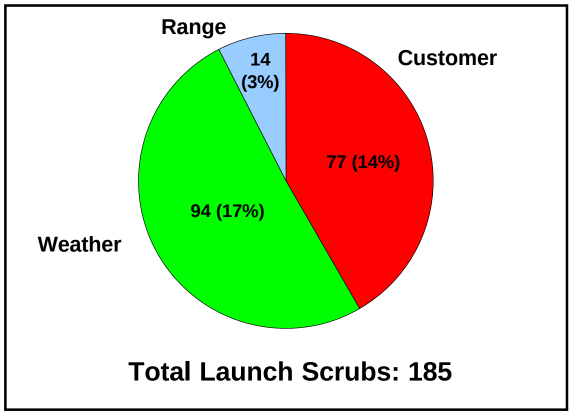


Figure 4 shows that of the 185 launch scrubs, 94 were due to weather factors (17 percent of the 555 total launch campaigns), 77 were due to customer concerns (14 percent of total), and only 14 were caused by range issues (three percent).

Figure 4. Scrubbed Launches by Cause Factor (FY1988 - FY2002)



Customer Factors

At the Eastern Range, customer factors accounted for 72 of the delayed launches (13 percent of 555 total launch campaigns) which occurred within the scheduled launch window. This means that customer issues were the first cause for delaying 72 launches out of a total 370 launches that occurred within the scheduled launch window. Customer factors represented the most common reason for launch delays for launches which took place during the first launch window opportunity. The following text explains a few reasons why this is the case.

During a launch, the payload operator, usually in tandem with representatives of the manufacturer, will continually monitor the payload throughout the execution phase and beyond. In most cases, once a payload separates from the vehicle, the responsibilities of the launch provider cease. While on the pad, the payload's functions are compared to established engineering and software parameters. If a particular reading appears anomalous, a hold on the launch is called by the operator or manufacturer of the payload and a delay follows. If the anomaly cannot be corrected, or a cause for the anomaly cannot be determined, the launch will be scrubbed so that a detailed analysis can be performed.

Likewise, a launch vehicle provider, with the assistance of the vehicle manufacturer, will monitor the vehicle throughout the launch campaign until the payload is delivered to its planned orbit. If the vehicle's readings are outside acceptable limits prior to launch, the launch provider will place a hold on the launch pending corrective action or analysis, a process that may result in a scrub.

If a launch vehicle is forced to remain idle after several scrubs, some of the final preparations might be reversed for safety and vehicle protection purposes. The payload might be "de-mated" to protect it from climate damage and propellant may be removed from the vehicle to prevent accidents or corrosion. The range may incur additional costs resulting from the necessity of converting and reconverting the range for a commercial launch.[5]

The inaugural launch of a vehicle can also be characterized by an unusual number of delays and scrubs. Because the vehicle's performance is untested, and because launch vehicles cannot undergo test flights like those undergone by aircraft prototypes, a great deal of effort is placed on removing any possible technical problem before launch. Very little is left to chance on any launch, but an inaugural launch is even more rigorously examined. The first launch of the Delta 4 was a good example, with at least two scrubs due to technical issues and several weather-related delays.

Most of the weather delays were attributed to winds aloft, because Boeing engineers did not want to risk exceeding vehicle tolerances as they had no historical data with which to work.[6]

From FY1988 to FY2002, payload and launch customer issues were the cause of 77 launch scrubs (14 percent of 555 total launch campaigns).

Weather Factors

Weather is the next most common reason for a launch delay during the first launch window opportunity. Weather factors caused the first delay of 52 launches of 370 launches that took place during the scheduled launch window (9 percent of 555 total launch campaigns). This represents 14 percent of the of the 370 launches that occured within the launch window during the FY1988 to FY2002 period.

Weather was the most common contributing factor in a launch scrub. The most common weather factor causing these scrubs were winds aloft and lightning. Winds aloft cause approximately 30 percent of all weather-related launch delays and scrubs and are a major issue because they cannot exceed the engineered tolerances of the vehicle as it ascends through the atmosphere. Of particular concern is the moment the vehicle enters maximum dynamic pressure (called max-Q), a segment of the flight path where a vehicle experiences the greatest amount of stress due to aerodynamic factors. Higher than expected winds can complicate this phase of the flight path, so they are monitored closely using weather balloons and other methods.

Another 30 percent of weather-related launch delays and scrubs are because of conditions conducive to lightning, as outlined in the launch commit criteria (LCC). The LLC provide range safety guidance to avoid natural and triggered lightning for expendable and manned launch attempts.[7] Other weather-related contributors to launch scrubs include surface winds, and in the case of Shuttle launches, weather conditions that would prevent the Shuttle from using the

Return To Launch Site (RTLS) abort mode or from landing at transatlantic landing sites. Weather was responsible for 94 scrubs (17 percent of 555 total launch campaigns), or about 51 percent of launch scrubs during the 14-year period.

Range Factors

The Eastern Range itself is the least common contributor to launch delays and scrubs. Despite this record, range reliability has apparently shown slow degradation in recent years due to obsolescence. Continued modernization efforts are under way and will address this trend.

Range factors contributed to the first delay of 43 launches of 370 launches that took place during the scheduled launch window (eight percent of 555 total launch campaigns). This represents 26 percent of the 370 launches conducted during the FY1988 to FY2002 period. It is also noteable that the statistics for delays or scrubs due to range factors include those instances when the delay or scrub is due to a fouled range, that is, aircraft, and/or sea vessels in the surveillance clearance box. Thus, the number of delays and scrubs due to range instrumentation failures is even lower than the numbers (43 delays, 14 scrubs) attributed to the range as a whole.

The launch range is not a major contributor of launch scrubs, at least during the 14-year period discussed in this report. Indeed, no launch scrubs were attributed to the range in the past four years. On average, range problems were responsible for only 14 scrubs (only three percent of 555 total launch campaigns), or about eight percent of the 185 scrubs that occured during the FY1988 to FY2002 period. During the entire FY2002 period, none of the 18 launch campaigns experienced delays or scrubs due to range problems, and there has been no launch scrub caused by range instrumentation in the past four years.

CONCLUSIONS

The data for launch campaigns supported by the Eastern Range from FY1988 through FY2002 indicate that almost 70 percent of launch campaigns are successfully executed within the scheduled launch window, with slightly over 30 percent being scrubbed and subsequently rescheduled.

For the 370 launches that took place within the launch window, the first delay reason is customer concerns. Customer issues account for 20 percent of these launches, or 13 percent of the total 555 launch campaigns.

Slightly over 50 percent of the 185 launch scrubs are due to weather, or roughly 17 percent of the total 555 launch campaigns.

ENDNOTES

[1] Maier, Michael W., “Eastern Range Launch Performance: Recent History and Opportunities for Improvement,” 4th Annual NRO/AIAA Space Launch Integration Forum, March 4, 2003.

[2] Davis, D., T. Wilfong, B. Shaw, K. Winters, and W. Schmeiser, “Tailoring the Advanced Weather Interactive Processing System (AWIPS) for Space Launch Range Support,” Paper 7.4 at the Interactive Symposium on the Advanced Weather Interactive Processing System (AWIPS), January 2002, Orlando, FL.

[3] Boeke, Cynthia, “2002 Satellite Survey: Via Satellite’s Global Satellite Survey: Trends and Statistics,” May 8, 2003.

[4] “The Future Management and Use of the U.S. Space Launch Bases and Ranges: Report of the Interagency Working Group,” February 8, 2000.

[5] Carlson, Caron, “Launch Delays May Increase Costs,” *Wireless Week*, April 21, 1997.

[6] Ray, Justin, “Boeing Delays Debut Launch of Delta 4 Rocket,” *Spaceflight Now*, November 15, 2002.

[7] Diller, George, “Florida Airborne Field Mill Research May Improve Launch Weather Criteria,” NASA/KSC Press Release 56-00, July 11, 2000.

First Quarter 2003 Orbital Launch Events

Date		Vehicle	Site		Payload or Mission	Operator	Use	Vehicle Price	L	M
1/6/03		Titan 2	VAFB		Coriolis	Department of Defense	Scientific	$30-40M	S	S
1/13/03		Delta 2 7320	CCAFS		ICESat	NASA	Remote Sensing	$45-55M	S	S
					CHIPSat	NASA	Scientific		S	S
1/16/03		Shuttle Columbia	KSC		STS 107	NASA	Scientific	$300M	S	F
1/25/03		Pegasus XL	CCAFS		SORCE	NASA	Scientific	$14-18M	S	S
1/29/03		Delta 2 7925-10	CCAFS		Navstar GPS 2R-8	USAF	Navigation	$45-55M	S	S
					XSS-10	Air Force Research Laboratory	Development		S	S
2/2/03		Soyuz	Baikonur		Progress ISS 10P	ISS Partner Nations	ISS	$30-50M	S	S
2/15/03	√	Ariane 44L	Kourou	*	Intelsat 907	Intelsat	Communications	$85-125M	S	S
3/10/03		Delta 4 Medium	CCAFS		DSCS 3-13	USAF	Communications	$65-75M	S	S
3/28/03		H 2A 202	Tanegashima		IGS 1A	Japan Defense Agency	Classified	$70-100M	S	S
					IGS 1B	Japan Defense Agency	Classified		S	S
3/31/03		Delta 2 7925-10	CCAFS		Navstar GPS 2R-9	USAF	Navigation	$45-55M	S	S

√ Denotes commercial launch, defined as a launch that is internationally competed or FAA-licensed.
+ Denotes FAA-licensed launch.
* Denotes a commercial payload, defined as a spacecraft that serves a commercial function or is operated by a commercial entity.
L and M refer to the outcome of the Launch and Mission (immediate status of the payload upon reaching orbit): S = success, P = partial success, F = failure
Note: All launch dates are based on local time at the launch site at the time of launch.

Second Quarter 2003 Projected Orbital Launch Events

Date		Vehicle	Site		Payload or Mission	Operator	Use	Vehicle Price
4/2/2003		Molniya	Plesetsk		Molniya 1T	Russian Ministry of Defense	Communications	$30-40M
4/8/2003		Titan 4B/Centaur	CCAFS		Milstar F6	USAF	Communications	$350-450M
4/9/03	√	Ariane 5G	Kourou	*	Insat 3A	Indian Space Research Organization (ISRO)	Communications	$125-155M
				*	Galaxy 12	PanAmSat	Communications	
4/11/03	√ +	Atlas 3B	CCAFS	*	AsiaSat 4	Asia Satellite Telecommunications Co. (Asiasat)	Communications	$65-75M
4/24/2003		Proton K	Plesetsk		Kosmos 2397	Russian Ministry of Defense	Classified	$60-85M
4/26/2003		Soyuz	Baikonur		Soyuz ISS 6S	ISS Partner Nations	ISS	$65M
4/27/03		Delta 2 7920H	CCAFS		Space Infrared Telescope Facility	NASA	Scientific	$45-55M
4/29/03	√	Proton K	Baikonur	*	AMC 9	SES Americom	Communications	$60-85M
4/2003		Long March 2C	Taiyuan		FSW 18	China Aerospace Corporation	Scientific	$20-25M
5/4/2003		Pegasus XL	CCAFS		GALEX	NASA	Scientific	$14-18M
5/7/2003		VLS	Alcantara		Unosat	Universidade Norte do Parana	Development	$8M
					SATEC	Instituto Nacional de Pesquisas Espaciais (INPE)	Development	
5/9/03		M 5	Kagoshima		Muses C	Institute for Space and Astronautical Sciences (ISAS)	Scientific	$50-60M
5/12/2003	√ +	Atlas 5 401	CCAFS	*	Hellas-Sat 2	Hellas Sat Consortium Ltd.	Communications	$65-75M
5/23/03	√ +	Pegasus XL	VAFB	*	OrbView 3	ORBIMAGE	Remote Sensing	$14-18M
5/25/03	√ +	Zenit 3SL	Odyssey Launch Platform	*	EchoStar 9	Echostar Communications Corporation	Communications	$65-85M
5/2003		Long March 4B	Taiyuan		CBERS/Ziyuan 2	China/Brazil	Remote Sensing	$25-35M
5/2003		GSLV	Professor Satish Dhawan Space Center		Gsat 2	Indian Space Research Organization (ISRO)	Communications	$30-40M
6/6/2003	√	Soyuz	Baikonur		Mars Express Orbiter	European Space Agency (ESA)	Scientific	$30-50M
					Beagle 2	European Space Agency (ESA)	Scientific	
6/6/03		Delta 2 7925-10	CCAFS		MER A	NASA	Scientific	$45-55M
6/8/03		Soyuz	Baikonur		Progress ISS 11P	ISS Partner Nations	ISS	$65M

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Note: Ariane 5 payloads are usually multi-manifested, but the pairing of satellites scheduled for each launch is sometimes undisclosed for proprietary reasons until shortly before the launch date.

Second Quarter 2003 Projected Orbital Launch Events

Date		Vehicle	Site		Payload or Mission	Operator	Use	Vehicle Price
6/15/03		Pegasus XL	VAFB		Scisat 1	Canadian Space Agency (CSA)	Scientific	$14-18M
6/16/03		Atlas 2AS	VAFB		NRO A3	NRO	Classified	$65-75M
6/2003		Titan 2	VAFB		DMSP 5D-3-F16	USAF	Meteorological	$30-40M
6/25/03		Delta 2 7925H	CCAFS		MER B	NASA	Scientific	$45-55M
6/30/03		Rockot	Plesetsk		MOST	Canadian Space Agency (CSA)	Scientific	$12-15M
					Mimosa	Czech Academy of Sciences	Scientific	
					QuakeSat	QuakeFinder	Scientific	
6/2003	√	Ariane 5G	Kourou	*	Optus C1	Optus Communications Pty. Ltd.	Communications	$125-155M
				*	BSat 2C	Broadcasting Satellite System Corp. (BSAT)	Communications	

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Third Quarter 2003 Projected Orbital Launch Events

Date		Vehicle	Site		Payload or Mission	Operator	Use	Vehicle Price
7/1/03		Delta 4 Medium	CCAFS		DSCS 3-14	USAF	Communications	$65-75M
7/17/03	√ +	Atlas 5 521	CCAFS	*	Rainbow 1	Cablevision Systems Corporation	Communications	$70-85M
7/24/03		Delta 2 7925-10	CCAFS		Navstar GPS 2R-10	USAF	Navigation	$45-55M
7/2003	√	Cosmos	Plesetsk		BilSat 1	Disaster Monitoring Constellation (DMC) Consortium	Remote Sensing	$12M
					BNSCSat	Disaster Monitoring Constellation (DMC) Consortium	Remote Sensing	
					NigeriaSat 1	Disaster Monitoring Constellation (DMC) Consortium	Remote Sensing	
7/2003		H 2A 202	Tanegashima		IGS 2B IGS 2A	Japan Defense Agency Japan Defense Agency	Classified Classified	$70-100M
7/2003	√	Shtil	Barents Sea		Cosmos 1	The Planetary Society	Development	$1-2M
8/2003	√	Ariane 5 TBA	Kourou	*	SatMex 6	Satelites Mexicanos S.A. de C.V.	Communications	$125-155M
					SMART 1	European Space Agency (ESA)	Development	
8/2003	√ +	Atlas 2AS	CCAFS	*	Superbird 6	Space Communications Corporation (SCC)	Communications	$65-75M
9/15/03		Titan 4B/Centaur	CCAFS		NRO T4	NRO	Classified	$350-450M
9/18/03		Soyuz	Baikonur		Progress ISS 12P	ISS Partner Nations	ISS	$65M
9/18/03		Delta 2 7920	VAFB		Gravity Probe B	NASA	Scientific	$45-55M
9/23/2003		Delta 4 Heavy	CCAFS	*	Delta 4 Heavy Demosat	Boeing	Development	$140-170M
3Q/2003		PSLV	Professor Satish Dhawan Space Center		IRS P6	Indian Space Research Organization (ISRO)	Remote Sensing	$15-17M
3Q/2003	√	TBA	TBA	*	APStar 5	APT Satellite Co., Ltd.	Communications	TBA
3Q/2003	√	Proton M	Baikonur	*	Intelsat 10 02	Intelsat	Communications	$70-100M
3Q/2003		Strela	Baikonur	*	Strela Test Payload	NPO Machinostroyeniya	Test	$10M
3Q/2003	√ +	Zenit 3SL	Odyssey Launch Platform	*	Thuraya 2	Thuraya Satellite Telecommunciations Company	Communications	$65-85M
3Q/2003		H 2A TBA	Tanegashima		MTSat 1R	Japanese Ministry of Transport and Japan Meteorological Agency	Navigation	$70-100M

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